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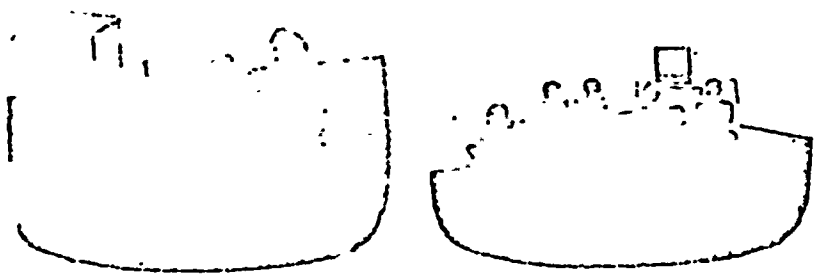
Programed instruction may be more efficient and effective when an individualized, fixed pace is chosen for the student. Three studies done in the Pittsburgh city schools to determine the relative merits of instruction at a fixed pace versus a self-adopted pace and several results. In the first experiment, one in which students paced themselves, some chose a rate which produced more errors and a lower posttest score than was expected. Work rate and ability varied independently but showed a consistent pattern for each student from program to program. The second experiment investigated a variety of pacing techniques. The slow tempo, fixed-paced presentation resulted in higher group achievement scores but caused efficiency to suffer since some students apparently were forced to work more slowly than necessary. In the third experiment, where external pacing was employed to help offset difficulties attendant on increased tempo, the cuing or pacing did lower error frequency but did not improve achievement. Results also provide some indication that multi-track programs with varying tempos, which are prescribed for students based on their characteristic work rate, might result in the most efficient and effective instruction. The studies may be particularly relevant when using a medium (e.g., television) which requires a fixed-paced presentation. (JY)



4. A SUMMARY REPORT

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and
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METROPOLITAN PITTSBURGH EDUCATIONAL TELEVISION STATION
and the AMERICAN INSTITUTES FOR RESEARCH

4. A SUMMARY REPORT

FOREWORD

The research reported in this volume was conducted under a grant from the U. S. Department of Health, Education, and Welfare, Office of Education, under title VII, the National Defense Education Act of 1958, Project No. 872; Grant No. 7-48-0000-159. Data analyses were partially supported by a National Science Foundation grant (No. G-11309) to the University of Pittsburgh Computing Center.

The proposal for this project was based on an award-winning research plan submitted by the Principal Investigator to the Television Research Plans Competition sponsored by the Television Bureau of Advertising (Gropper, 1963)*.

The authors are grateful to numerous people for their participation and cooperation in this project including: Dr. Evan Ingram of the Pittsburgh City Schools and Sister Rosalie of the Diocesan Schools in Pittsburgh for their help in enlisting the participation of pupils and teachers in this project; to the staff of WQED for their work in the production of televised lessons used in the project; to Charlotte Conley and Martha Scott for their aid in reproducing this report; and to Margaret Samways and Zita Glasgow for their preparation of programmed materials used in the study.

George L. Gropper

and

Gerard C. Kress, Jr.

December 1964

*Gropper, G. L. An experimental evaluation of procedures for "individualizing televised instruction. In L. Arons & M. A. May (Eds.) Television and Human Behavior - Tomorrow's research in mass communication. New York: Appleton-Century-Crofts, 1963.

INTRODUCTION

To most programmers it may seem paradoxical, and perhaps even unsound, to suggest that instruction may be more effectively "individualized" if it is fixed-paced rather than self-paced. While it is true that individuals do indeed have different pacing requirements, it does not follow that the pace which individuals adopt necessarily meets their individual needs. A consistently fast, self-adopted pace which leads to high error rates is clearly not compatible with high achievement. A consistently slow, self-adopted pace, compatible with high achievement, is not compatible with the goal of instructional efficiency. These pacing failures are not hypothetical; they do occur. If learning effectiveness, on the one hand, or learning efficiency, on the other, is to be improved, lessons delivered at a specially designed fixed pace may clearly be the remedial individualization needed by those who exhibit non-adaptive self-pacing patterns.

It is also true that fixed-paced instruction can, itself, lead to non-adaptive performance. Externally selected tempos can be, as in the case of self-paced instruction, too fast to be compatible with high achievement or too slow to be compatible with learning efficiency, at least for some learners. These conditions, too, are not hypothetical; they do occur. It would appear that similar problems in attaining individualized instruction are created no matter which pacing mode is selected.

It is unsound to assume that instruction is individualized simply because each student is allowed to adopt his own pace. It is equally unsound to assume that instruction is not individualized simply because presentation tempos are externally determined with no student allowed to adopt his own pace. The most trustworthy evidence that instruction has indeed been individualized comes from dependent measures describing group performance reflecting widespread learning effectiveness and efficiency. An instructional technology must be able to specify under what conditions either self-paced or externally-paced instruction can produce acceptable performance levels.

This report summarizes the results of three studies bearing on the relationship between pacing mode and performance. The first, dealing only

with self-paced instruction, discusses the determinants of a self-adopted pace and the effects of the pace adopted on performance. The second study presents results showing the effects of fixed pacing on performance and also provides evidence concerning the relative effectiveness of self-paced and fixed-paced instruction. The third study, dealing with television instruction, reports on the relative effectiveness of alternative approaches toward individualization of fixed-paced programmed instruction. Together, they provide a body of data describing failures in the individualization of instruction which can occur as a result of inappropriate paces either adopted by the learner himself or selected for him by those whose task it is to instruct him. The data also affirmatively suggest some solutions to both types of pacing problems.

STUDY 1: INDIVIDUAL DIFFERENCES IN LEARNING FROM SELF-PACED PROGRAMMED INSTRUCTION[1]

In order to study how the individual pace adopted by a student affects his performance, two science programs, each approximately 100 frames in length, were administered to two separate groups of eighth graders (N = 252 and 356). Using correlational, regression, and variance analyses, interrelationships among such performance measures as work rate, number of errors, and achievement scores were observed. In addition, these variables were also related to such individual difference measures as IQ, reading comprehension, and level of entering knowledge. Based on these analyses, it was possible to identify predictors of the pace or work rate a student adopts and to assess the effect which variations in work rate has on performance.

Effect of self-pacing on performance. - On well tried-out programs, it might be expected that there would be no differences in errors or in

[1]Kress, G. C., Jr. & Gropper, G. L. Individual differences in learning from self-paced programmed instruction - Report #1. Studies in televised instruction: Individualizing group instruction. Pittsburgh: American Institutes for Research, 1964. (a)

achievement between groups who worked at a fast or at a slow pace. Ideally, the pace adopted by an individual is appropriate to his needs. The main effect observed in this study, however, was that students whose self-adopted rate was "fast" generally made more errors and scored lower on posttests than did their slower counterparts. Since the fast and slow groups were matched for ability and prior knowledge, these effects appear to be directly attributable to the rate or pace at which students worked through the programs.

The interactions observed, however, indicated that most of this effect was due to variations among low IQ students. While there was relatively little difference in performance among high IQ students who either worked at a slow or at a fast pace, there were substantial differences among low IQ students who worked at a slow pace and low IQ students who worked at a fast pace. Much in keeping with programming theory, the pace high IQ students adopted, whether fast or slow, led to uniformly high achievement. Not in keeping with programming theory, however, are the findings for low IQ students, precisely the group programming theory asserts needs the benefit of the extra time self-pacing is supposed to provide. Superior performance was observed for those low IQ students who did work at a slow rate. But low ability students in substantial numbers worked at a rate which was apparently too fast to permit low-error, high-achievement performance. Thus, low IQ students neither performed as well as their high IQ fellows, nor did they perform at a uniform level among themselves. Questions therefore arise as to the possibilities of accommodating individual differences in ability by allowing all students to pace themselves.

Accommodating individual differences through self-pacing. - If self-adopted work rate does not to a sufficient degree accommodate individual differences in ability, it cannot be said to be due to lack of variability in its distribution. The slowest students in the entire distribution took more than twice as much time as the fastest students. Thus, there was sufficient range of inter-individual variability in work rate to match or to reflect inter-individual variability in ability. But, while work rate and ability varied independently to a high degree, they varied together to only a moderate degree, as shown by the four correlations obtained between work rate and Otis IQ. These ranged from -.32 to -.44,

with an average r of -.38. Too many high ability students worked at a pace which was inefficient, although it certainly allowed them to reach high achievement levels. Perhaps more seriously, too many low ability students worked at a pace which was too fast for them to allow high level achievement.

Thus, allowing students to retain control over their own pacing requirements leads to work rates which, while exhibiting substantial inter-individual variability, fail to eliminate inter-individual variability in performance. Differences in ability and prior knowledge are not fully discounted even though students working on well tried-out programs are allowed to pace themselves. Self-selection of work rate appears to be non-adaptive for many students and the particular rate assumed appears to be for many students more closely linked with and predicted by non-ability variables.

Stability of work rate. - One of the most striking findings of this study is the consistency of students from program to program as to the pace or work rate they adopt. The relationship between a measure of work rate on one program and work rate on another is quite high, the average of two obtained correlations being approximately .80. A similar, but slightly lower consistent relationship holds for errors on one program and errors on another ($r = .78$). These relationships remain high even when the effect of ability and prior knowledge of subject matter is controlled. The extent of such consistency can be seen even more clearly in the tendency of students to exhibit similar combined work rate and error patterns on both programs. Fifty percent of the sample in the present study exhibited the same combined work rate and error pattern on the second program as they did on the first.

The high reliability of these performance measures and their high self-predictive power (relative to other measures such as IQ and levels of prior knowledge and with these other measures controlled) suggest that they all reflect a stylistic or characteristic performance. Each student appears to work at a rate that is characteristic of him. Relatively independent of his ability and of the difficulty he experiences, his work rate, it is interpreted, reflects his characteristic reading speed and his characteristic work habits. This interpretation is supported by the

additional findings of consistent error patterns and of consistent, joint work rate and error patterns. Students can race through programmed materials, often ignoring the fact that they are committing errors, or they can work at a deliberate pace. They can toss off their answers or ploddingly compose and record them. Whichever they do on one program, they appear to repeat in similar fashion on the second program. These findings suggest that one of the reasons work rate does not bridge individual differences in ability is that students work at a rate which appears to be less than completely determined by the learning task, by the perceived difficulty in performing it, or by success or failure in completing it.

Implications. - If programmed instruction is to succeed in substantially reducing inter-individual differences in terminal achievement, as conventional instruction has not been able to do, it would seem desirable that control be exercised over student learning behavior to a far greater degree than is now being done. Only those students who demonstrate on screening programs that they can work at a pace which permits them to reach satisfactory achievement levels should be permitted to pace themselves. Those who do not, should, perhaps, have a pace determined for them. This, of course, would most likely be the case for low IQ students who work too fast. On the other hand, high IQ students who work slowly, might be successfully speeded up. The results in this report have only described, after the fact, what happens when students attempt to learn at a self-selected pace. They provide no experimental evidence, which is necessary to answer the questions just raised, as to whether externally controlled pacing will remedy the problem. The evidence here does suggest, however, that when low ability students do work at a pace appropriate to their ability level they are more likely to reach high achievement levels. However, since allowing students to retain control over the rate at which they work does not invariably result in their adopting an optimal work rate, means must be found to insure that they do.

No conclusive statement can be made at this time about the generality of these findings. They are based on the performance of eighth-grade students who are apt to be more heterogeneous in ability and, perhaps also in motivation, than the more highly screened college population and

perhaps less heterogeneous than grade-school students. Whether older students or adults who have survived additional selection processes work at a more adaptive pace, remains to be determined empirically. Among younger students, it might be conjectured, self-selection of work rates is likely to be no more adaptive, and perhaps even less so. This also is important to determine empirically.

These results have implications not only for the kinds of research issues concerning pacing modes which merit investigation. They also suggest serious reconsideration of work rate as a dependent variable in research concerned with other programming issues. Since work rate appears to be a highly stable characteristic of individuals, caution appears warranted when work rate is treated as a dependent variable to assess the effects of variations made in program variables. Either systematic, prior matching of Ss for characteristic work rate or subsequent tests for its equation by random assignment should be performed. Otherwise, significant differences between groups with respect to work rate may be spurious, simply reflecting differences in work rate which existed before experimental treatments were initiated. Moreover, given the apparent, relatively stable nature of work rate, it may be unduly optimistic to expect changes in it to occur as a result of experimental manipulations. Whenever Ss are in fact matched for work rate and differences between experimental treatments can still be shown, rather persuasive arguments may be warranted regarding the potency of experimental treatments being investigated.

The findings of non-adaptive work rates exhibited by sizeable numbers of low ability students also have implications for strategies of program preparation, tryout, and revision. Common practice among programmers is to make revisions in programmed lessons, often quite drastic in scope, when high error rates are found in tryouts. The changes made generally reduce a program's step-size to make it more assimilable to lower ability students. This approach generally assumes that the self-selected pace is appropriate but that the cuing level of the program is inadequate. Changes made, based on this assumption, usually result in a program geared often to the lower end of the ability distribution. In view of the findings presented here, it is not unreasonable to speculate that efforts to make

programs more effective should as much revolve around pacing failures as around step-size considerations. Control over student pacing, for example, might result in programs geared to somewhat higher ability levels than is currently the case. Thus student pacing failures would not be confused with the programmer's failure in program preparation, and the more laborious task of revising programs would be postponed until it was determined that high error rates and insufficiently high achievement were not due first of all to pacing problems. Substantial improvement in achievement might be realized before revision is even attempted by simply requiring students to assume a pace more appropriate to their needs. Thus, control over work rates would be exercised for those students who demonstrate a need for it.

The protagonists of programmed instruction, particularly the behaviorists among them, attribute much of its success to the high degree of control exercised over the conditions under which response is made to follow stimulus and reinforcement to follow both. Antagonists are apt to chafe over precisely this measure of control. The evidence cited in this study appears to support the hypothesis that even more, not less, control may be needed. Specifically, those students who work at non-adaptive rates might be required to work under fixed-paced conditions selected for them, or, perhaps, undergo training until they demonstrate that they can adopt appropriate work rates.

STUDY 2: THE INFLUENCE OF EXTERNAL PACING ON LEARNING AND A COMPARISON OF SELF-PACED AND FIXED-PACED PROGRAMMED INSTRUCTION[2]

Whether or not it is recommended for use for remedial purposes, fixed-paced instruction is already with us. Filmed or televised demonstrations which are necessarily fixed-paced in character serve important functions in well designed instructional strategies. Since fixed-paced instruction has a role to play, either for remedial or for standard instructional purposes, it is important to determine how fixed-paced group presentations can meet what are likely to be the varied pacing requirements of individuals.

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[2] Kress, G. C., Jr. & Gropper, G. L. The influence of external pacing on learning from programmed instruction - Report #2. Studies in televised instruction: Individualizing group instruction. Pittsburgh: American Institutes for Research, 1964. (b)

If uniformly high achievement levels are to be attained, a presentation pace must be found which is adequate for group needs.

Using a wider range of tempos than that encountered in previous studies, the aims of the present study were as follows: (1) to determine what effect variations in tempo have on student performance; (2) to determine whether students differing in ability or in characteristic (self-paced) work rate experience these effects differentially; and (3) to compare the relative effectiveness of fixed-paced and self-paced programmed instruction. For this purpose, eighth grade students were required to learn from an approximately 100 frame program on "electricity" presented either on slides (at different fixed tempos) or in booklets (at a self-adopted pace). On the basis of the work rate they adopted on preliminary self-paced programs, students participating in this study were identified as being characteristically fast or slow. Only those who, in addition, reached a minimum achievement level (70%) were retained for the fixed-paced experiment. Thus, their work rate "qualified" as a true work rate (one which permits acquisition) and, variations in this rate could be studied for their interaction with fixed-tempo variations. Since only "qualifying" students were included, this study can only answer questions about the effects of fixed tempos on "qualifiers." It cannot answer questions as to the remedial possibilities of using fixed tempos for "non-qualifiers."

Effects of variations in tempo on performance. - Performance during work on a program, rather than after its completion, is most directly and most clearly affected by variations in externally controlled tempo. The faster the presentation, that is to say, the shorter the duration of stimulus exposure and of the opportunity to respond, the more difficult do responses become and more likely are errors to be committed. The increasingly fast tempo levels employed in this experiment were indeed accompanied by increases in average error rates, increasing from 7.8 percent in the slow condition to 10.2 percent in the medium speed condition to 15.7 percent in the fast condition. This represented a doubling of errors as the allotted working time was approximately halved.

While it is true that performance deteriorated uniformly as tempos became faster, it is interesting to note that even in the fastest condition, the mean error rate was no higher than 16 percent. The data and

observation of Ss during the presentation strongly suggest that there was a bias toward a slower work rate than was perhaps indicated for the Ss who participated in this experiment. This undoubtedly contributed to a reduction in the negative effects which increased tempos might have been expected to have on student errors. Despite this bias, significant differences in errors were found among the three tempo levels with the fast tempo, as expected, producing the largest number of errors. Thus, with the cuing level provided by lesson content held constant across tempo levels, but with cuing level as influenced by stimulus exposure times increasingly reduced, decrements in performance resulted. But, in view of the magnitude of the error rates observed, it might be expected that achievement data would not exhibit equally pronounced decrements. Similar decrements were not in fact observed in achievement data.

There is little empirical evidence to suggest what the critical error rate is which will result in achievement decrement. It is highly likely that it will vary from program to program depending, perhaps, on such factors as the programming style, the subject matter being taught, the behavioral strategy being implemented, the types of responses required, etc. In view of the rather complex interrelationships between errors and achievement, the failure to find reliable achievement differences among tempo levels, even though error differences were reliable, should create no particular surprise. It is reasonable to conclude from the present findings that increases in tempo do produce performance decrement during work on the program itself. Impairment of achievement would be expected to result when such error decrement becomes sufficiently high.

Differential effects of increases in tempo. - The performance of students varying in abilities and in work habits was differentially impaired. Students varying in ability, as measured by the Otis Group IQ Test, and varying in characteristic work rates, as estimated on the basis of performance on two self-paced programs, responded differentially to the fixed-paced presentations. With characteristic work rates controlled, it was found that, across all the fixed-tempo conditions, above average students generally outperformed their less able fellows. Moreover, as tempos increased, the gap between them even tended to widen.

As exposure durations of stimulus materials and the opportunity for responding shorten, it would be expected that heightened response difficulty would be experienced by all students. However, since response difficulty as a function of the cuing value of lesson content is already apt to be different for the above and below average student, even under self-paced conditions, the reduction of cuing value by shortening of exposure times might be expected to be non-uniform in its effect on students of varying ability. Students already having more difficulty responding to lesson materials might be expected to be more seriously handicapped by reduction in cuing levels than students experiencing less difficulty. It is, of course, not possible to describe on the basis of the data available precisely what this interactive function might be. Increases in tempo, however, might be thought to create out of exactly the same lesson content a program of different step-size for students varying in ability. Thus, while any given frame in a program may, to begin with, constitute a large or a small step for students varying in ability, variations in tempo may be an additional factor capable of increasing its size. As a result, its effects may interact with ability.

Differences among students in characteristic, self-adopted work rates also generally led to differences in performance across all fixed-tempo conditions. In addition, it was found that with IQ controlled, characteristically fast students outperformed their slower counterparts. This was the opposite of the findings presented in study #1. However, it will be remembered that there the results of non-qualifiers as well as of qualifiers were studied. In the present study, the characteristically fast Ss were qualifiers, that is, those who performed adequately under self-paced conditions even though they adopted a fast pace. Thus, it might be expected that when a pace is imposed upon them, they might still be able to perform adequately even though the pace selected for them is fast. And, they might be expected to withstand the attendant increase in difficulty better than those Ss who are characteristically slow. That is what occurred. Students who were characteristically fast under self-paced conditions were better able to withstand the effects of increased tempos than were the characteristically slow students.

A comparison of self vs. fixed pacing. - It might have been expected that the students who worked under self-paced conditions in this study would have done as well or better than the fixed-paced group. They, after all, were "qualifiers." They had demonstrated that they could, when allowed to do so, adopt a pace compatible with moderately high achievement. By being allowed to pace themselves now, each student would be expected, on the basis of his previous performance, to adopt a pace congenial to him and still compatible with high achievement. Instruction would be, many would claim, ideally individualized.

Students in the self-pacing group, as it turned out, adopted a pace comparable to the fast, fixed pace. As a result, it would appear, their achievement scores, although high, were not as high as those of the slow fixed-tempo group. Thus, despite the fact that they were reasonably well qualified self-pacers, when they adopted their own pace in the main experiment, they were outperformed (on achievement tests) by students who were paced by the experimenter-controlled, slow presentation.

Implications. - On the basis of the evidence obtained from studies 1 and 2, it seems clear that the pace at which a student works on a program can be non-adaptive whether it is self-selected or externally imposed. Under self-paced conditions students can on their own adopt a pace which is too fast to be compatible with high achievement. Similarly under fixed-paced conditions they can be forced to work at a pace which is too fast to be compatible with high achievement. The remedy for the latter problem, particularly necessary for presentations on film or television which of necessity must be fixed-paced, is quite clearly apparent: a slower, fixed pace can be selected that is compatible with high achievement. It is possible for fixed-paced presentations to select the pace at which, on tryouts, a predetermined percentage of Ss in a pilot group attains a predetermined achievement level. Another possibility, to be discussed in study #3, is to provide more than one program source, with each tailored to the particular pacing requirements of the group receiving it.

The solution to the problem concerning the non-adaptive pace at which the self-paced group works is not so apparent. The results of the present experiment have not shown that people who performed poorly under self-paced conditions improved under fixed-paced conditions. The experiment

was not designed to do so. They have shown only that fixed pacing when sufficiently slow can produce higher average achievement levels than self-pacing. The fact that controlling the pace at which "qualifiers" worked resulted in performance superior to that of "qualifiers" who worked at a self-adopted pace, strongly suggests, however, that it might also prove effective for non-qualifiers, those most in need of an alternative to self-pacing. Their achievement levels certainly allow more room for improvement than was possible for the self-paced qualifiers studied here. A research design addressing itself explicitly to this problem must of course include non-qualifiers in the sample.

The present study has merely served to provide evidence as to the effect which increases in tempo might have on the performance of qualifiers. It has also served to show that even the performance of qualifiers whose pace is externally controlled can be superior to that of qualifiers who adopt their own pace. When sufficiently slow, it can lead to performance levels superior to that occurring under self-paced conditions. While achievement levels prove adequate as a result of a slow enough fixed tempo, efficiency necessarily suffers. High group achievement requires a slow, fixed pace. It may be that many students who perform well at a slow fixed pace are being forced to take more time than they actually need to perform well.

Using only one program source, there appear to be unavoidable trade-offs. Learning effectiveness is gained at the expense of learning efficiency. Study #3 deals specifically with ways of meeting this problem.

STUDY 3: ACCOMMODATING INDIVIDUAL DIFFERENCES DURING EXTERNALLY-PACED PROGRAMMED INSTRUCTION[3]

While it is possible to produce high levels of group achievement under externally set tempos, the tempo required to do so is generally too slow

[3]Kress, G. C., Jr. & Gropper, G. L. Accommodating individual differences during externally-paced programmed instruction - Report #3. Studies in televised instruction: Individualizing group instruction. Pittsburgh: American Institutes for Research, 1964. (a)

to be compatible with learning efficiency. The purpose of this study was, therefore, to assess two strategies for increasing the learning efficiency of fixed-paced television instruction. One strategy called for a single program source using added response-prompting as a means of keeping error rates low despite the fact that presentation tempos are increased. The second strategy to be assessed concerns the value of using multi-track programs as a means of accommodating individual differences in ability and in pacing requirements.

Programmed science lessons, including verbal and visual materials, were presented over television to eighth-grade students. Twelve separate versions of the lessons were compared. Three levels of prompting strength were employed, including: an unprompted constructed response version, a version with added physical prompting (initial letters of words), and a completely prompted version. Four tempo levels were produced for each of these lessons differing in prompting strength, resulting in 12 versions altogether. Comparisons were made among treatments for errors, posttest scores, and retention scores.

The strategy of added prompting. - Here, as in study #2, increasing tempos led to significant increases in errors. Since increasing the tempo reduces stimulus exposure durations, it is reasonable to account for the heightened error rates in terms of the resulting reduction of the cuing or prompting value of the stimulus materials. The added physical prompts used in this study served to offset the tempo effect by increasing the cue-value of stimulus materials. That they were successful in doing so was shown in this case by the resulting reduction in errors. But this increase in cue-value across all tempo conditions was not accompanied by an improvement in achievement. On the contrary, achievement results tended to decline as the degree of prompting increased, and tests based on two of the four achievement measures obtained indicated that the decline was statistically significant.

The non-prompted condition produced the greatest number of errors. Surprisingly enough, in view of the known, moderately high negative relationship between errors and achievement (Kress & Gropper, 1964a), the same condition produced the highest achievement levels. These findings suggest the superiority of non-prompted response-practice, with errors,

over fully-prompted response-practice, with few or no errors. These findings, it should be pointed out, are not in keeping with those from several other studies of response mode. However, if learning under fixed tempos can be construed as learning under difficult conditions, the findings do appear to be in keeping with those studies which suggest that "overt" practice (non-fully prompted responding) is superior when the material to be learned is relatively difficult.

Generally, extra prompting, across all tempo conditions, resulted in poorer rather than improved student performance. Moreover, added prompting showed no significant or uniform, differential results for either fast or slow fixed-tempo conditions. In view of these findings, it would appear that, while added cuing does reduce error frequencies, it also alters the character of the learning experience sufficiently so that achievement is impaired rather than improved. Since achievement is the ultimate criterion of instructional effectiveness, prompting variations do not appear capable of offsetting the impairment created by increases in tempo. Therefore, as a strategy for accommodating individual differences in fixed-paced instruction, a single program source with added prompting does not appear to be very promising.

The strategy of separate program sources. - The present study did not offer alternative program sources to different, homogeneously constituted groups. It did however compare the performance of characteristically fast and slow workers (as determined under self-paced conditions) under different, externally controlled tempo conditions. The interactions observed between characteristic work rates and externally controlled tempos were not uniformly significant. However, the trends observed were uniform and are moderately persuasive. They suggest the possibility that greater individualization of instruction might be attained by creating homogeneous groupings presented with tempos tailored to their needs.

Students who characteristically adopted a fast pace under self-paced conditions and who demonstrated that they can achieve at the pace they adopted, learned more under a fast than under a slow fixed tempo. Any impairment created by the fast fixed tempo was felt more by the characteristically slow students. Under the fast fixed tempo, the characteristically slow workers achieved less than their characteristically fast counterparts

with whom they had been matched for IQ. The reason that slow students achieved less is likely to be that fast fixed tempos provide them with stimulus exposure durations shorter than those they are accustomed to. Whatever their characteristically slow work rate is due to, reading speed or work habits or both, the stimulus exposure durations of a fast fixed tempo are less likely to be sufficient to cue correct responding. Under the fast fixed tempo, characteristically slow students did exhibit a higher error rate and also tended to achieve less than their fast counterparts. Their test results were also lower than test results of their slow counterparts who performed under the slow fixed-tempo condition.

Thus, it appears that students who habitually and successfully (in terms of achievement) adopt a fast pace under self-paced conditions, when exposed to externally-set fast tempos, can adapt to them. Those who characteristically adopt a slow pace under self-paced conditions, when exposed to identical, externally-set fast tempos, adapt less well. Thus, despite the fact that efficiency may suffer, it appears necessary to allow characteristically slow students to work under a slow fixed-tempo condition.

Under slow, fixed tempos, the results are surprisingly the converse. If characteristically fast students can adapt to a fast fixed tempo, they would not be expected to have their performance particularly impaired under a slow fixed tempo. However, under the slow fixed-tempo condition, the characteristically fast students actually performed more poorly than the characteristically slow students working under the same condition. Moreover, the characteristically fast students in the slow fixed-tempo condition generally produced achievement results inferior to that of their characteristically fast counterparts working in the fast fixed-tempo condition. Since IQ was controlled in both these comparisons, these findings suggest that it was not ability to learn which produced these results.

A number of alternative explanations suggest themselves. Students who work at a fast pace were likely, under the slow fixed-tempo condition, to have completed each frame presented to them before its total exposure duration elapsed. This may have provided more opportunity for the practice of competing responses. Also, the interval between response and confirmation was longer for fast students than for slow students. While this study was not designed to measure motivation or attitude, these

findings also suggest the possibility that characteristically fast students may have been bored by the slow fixed-tempo condition. Whatever the explanation, it appears that the detrimental effects of inappropriate fixed pacing are not restricted to those characteristically slow students who are forced to work too rapidly. Too slow a pace for characteristically fast students, in addition to being inefficient, also leads to lowered learning effectiveness. It appears equally important, therefore, to assign characteristically fast students to a separate, fast condition tailored more closely to their pacing needs.

Implications. - It is suggested in study #1 that some students require slowing down. The evidence from that report suggested that below average students who adopt fast work rates and who fail to reach predetermined performance levels, might be candidates for such treatment. The "fast" students who were required to work under slow fixed-tempo conditions in the present study tended to do more poorly (in terms of achievement) than their "slow" counterparts under the same condition and more poorly than their "fast" counterparts under the fast fixed-tempo condition. However, it should be pointed out that the present study included only qualifiers (students who did achieve satisfactorily under self-paced conditions). Therefore, the "fasts" included here were, so to speak, true "fasts." Slowing them down had detrimental effects. Any study to determine whether non-adaptive "fasts" can be successfully slowed down must include non-qualifiers. The number of non-qualifiers included in the present study was insufficient to determine whether non-adaptive "fasts" can be successfully slowed down.

A further suggestion made in the first two reports of this series was that slow, but bright students who attain satisfactory achievement levels under self-paced conditions might be speeded up in the interest of greater learning efficiency. Screening procedures might be necessary, however, to determine which students, if any, might be successfully speeded up. The results of the present study revealed, in general, that characteristically slow students did more poorly under fast fixed tempos than their matched, slow counterparts did under slow fixed tempos. The "slows" represented students at all ability levels. Since no uniform IQ interactions were observed, it is difficult to determine whether some slow students might be more successfully speeded up than others.

inspection of independent variables, i.e., how many separate or individual treatments students are provided. Paradoxically, it does come from an inspection of dependent measures indicating how effective and efficient learning has been. Thus, while a small number of fixed-paced program sources does not, at least as far as numbers of separate "treatments" go, begin to approach the degree of individualization provided when students pace themselves, it can nevertheless be said to have resulted in individualization -- if it has made learning effectiveness or efficiency possible for an entire group. Stated this way, it becomes an empirical matter. The evidence from separate studies in this series suggests that "individualization" can occur even when student work pace is not individually selected.

The results of the present study, in general, suggest that characteristically slow students, for whom the slow pace is adaptive, may not be successfully speeded up without impairing their level of achievement. However, it must be remembered that the fast tempo employed in this study was not tailored to the needs of a particular group which was to be speeded up. It was, in fact, not tailored to any particular group. Based on the results of this study, it remains open to question whether a single, fast fixed tempo can be tailored so that it is suitable for characteristically fast students and for characteristically slow students who can be speeded up. It might be possible to identify a subgroup of slow students whose efficiency can be improved at no cost in achievement. Such identification, if possible, would require a more analytic examination of a larger sample of characteristically slow, high achievers. A compromise "fast" tempo delivered to such a subgroup, combined with characteristically fast workers, as long as it is not perceived as being slow by the characteristically fast students, would still be more efficient than either a self-adopted or an externally selected slow tempo. Whether such a compromise is possible remains an empirical problem.

While these considerations have been offered in part as remedies for students who in self-paced instruction adopt non-adaptive paces, they appear relevant to presentations which must of necessity be fixed paced. Filmed or televised demonstrations are fixed paced in character, and these pacing considerations are equally applicable to them as they are to verbal, printed presentations. If these types of presentations are to provide, as a first requirement, effective instruction, and, secondarily, efficient instruction, then separate program sources appear indicated. On the basis of the evidence obtained here, assignment to a particular program source can perhaps best be made on the basis of the individual student's characteristic work rate adopted under self-paced conditions.

CONCLUSION

The ideal outcome of individualized instruction is both effective and efficient instruction. Confining ourselves to a consideration of fixed-paced instruction which is offered because the medium required happens to be fixed paced in character, how can such instruction be both effective and efficient? When slow, it tends to be effective but inefficient. Unless it can be demonstrated that slow students can be speeded up, inefficiency may be the price that must be paid to make effectiveness possible for them. The trade-off is no different than that which is currently necessary in self-paced instruction.

Since fast workers appear to be capable of tolerating fast fixed tempos, slow fixed tempos would be even more inefficient for them. But, in addition, for fast workers, slow fixed-tempo instruction also appears to be ineffective. Thus, when fixed-paced instruction is fast, it is appropriately effective and efficient for fast workers. For slow workers it is considerably less effective and, as a result, its efficiency is of little concern to us.

These findings suggest that when fixed-paced presentations are offered in group settings, optimal effectiveness and efficiency can be attained by offering more than one program source, with each program source tailored to the needs of groups of students who share pacing requirements. While this study was not designed to determine how many such program sources might be necessary, it is not unreasonable to speculate, based on the achievement levels found here, that two program sources might fill the needs even of a group relatively heterogeneous in pacing requirements. For this purpose, it might be pointed out, the level of effort required to prepare alternative tempo presentations of the same lesson, relative to that required for initial program development, is quite small.

It has been shown that self-pacing can be non-adaptive (Kress & Gropper, 1964a), and that, under some circumstances, instruction can be more effective when it is fixed paced rather than self-paced (Kress & Gropper, 1964b). Thus, it seems clear that the best evidence as to whether individualization has been achieved, comes not from an